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ART III.—*Note on the Age and Palaeogeography of the Brown Coal Deposits of Gippsland, Victoria.*

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Marine micro-fossils including foraminifera, bryozoa and ostracoda were found in the lignitiferous beds referable to the Anglesean Stage (Middle Miocene), in deep bores in East Gippsland. Later they were discovered in lignitiferous material from bores drilled to prove the extent of the bauxite in the parishes of Mirboo and Budgerie and of the brown coal deposits in the parishes of Loy Yang, Maryvale and Hazelwood. Based on stratigraphic evidence provided by these fossils, it is suggested that the brown coals of the Yallourn formation accumulated during the Middle Miocene, Upper Miocene and probably basal Lower Pliocene.

Introduction.

Following the record by the writer (1943) of a micro-fauna in the lignitiferous clays and sandstones underlying the marine deposits in numerous deep bores in East Gippsland, it was decided to investigate the lignites and sediments associated with them, in the Traralgon, Morwell, Mirboo, and Budgerie areas.

A series of bores has been drilled by the Commonwealth and Victorian Governments in the Mirboo and Budgerie areas to prove certain of the bauxite deposits there. These bores revealed that, in places, lignites are interbedded with the clays and sands which overlie the bauxite. A microscopic examination of samples of this lignitiferous material showed the presence of a small micro-fauna consisting of minute foraminifera and fragments of bryozoa, indicative of Middle Miocene to lower Upper Miocene age.

In view of this discovery, the State Electricity Commission of Victoria was asked by the Mineral Resources Survey to supply samples of the Yallourn Formation (Crespin, 1943) met with in bores put down to test the brown coal deposits in the Morwell and Traralgon districts. The Commission kindly complied with this request and samples have now been examined from bores in the parishes of Maryvale, Hazelwood, and Loy Yang. As a result a micro-fauna has been found. In preparing these samples for micro-examination every precaution was taken to avoid the inclusion of any adventitious material. That this fauna is indigineous to the lignitiferous beds is supported by the similarity of forms and by the manner of preservation of the fossils.

Bores from which Samples have been Examined.

(1) BORES TO PROVE THE BAUXITE DEPOSITS.

PARISH OF MIRBOO.

- (a) Bore No. 27, from 26 feet to 36 feet, and 14 feet above the bauxite.

PARISH OF BUDGEREE.

- (b) Bore No. 15, from 105 feet to 110 feet, and 15 feet above the bauxite.
- (c) Bore No. 16, from 103 feet and 26 feet above the basalt. (No bauxite was recorded from this bore).
- (d) Bore No. 18, from 89 feet to 90 feet, and 14 feet above the bauxite.

(2) STATE ELECTRICITY COMMISSION BORES TO PROVE BROWN COAL.

PARISH OF HAZELWOOD.

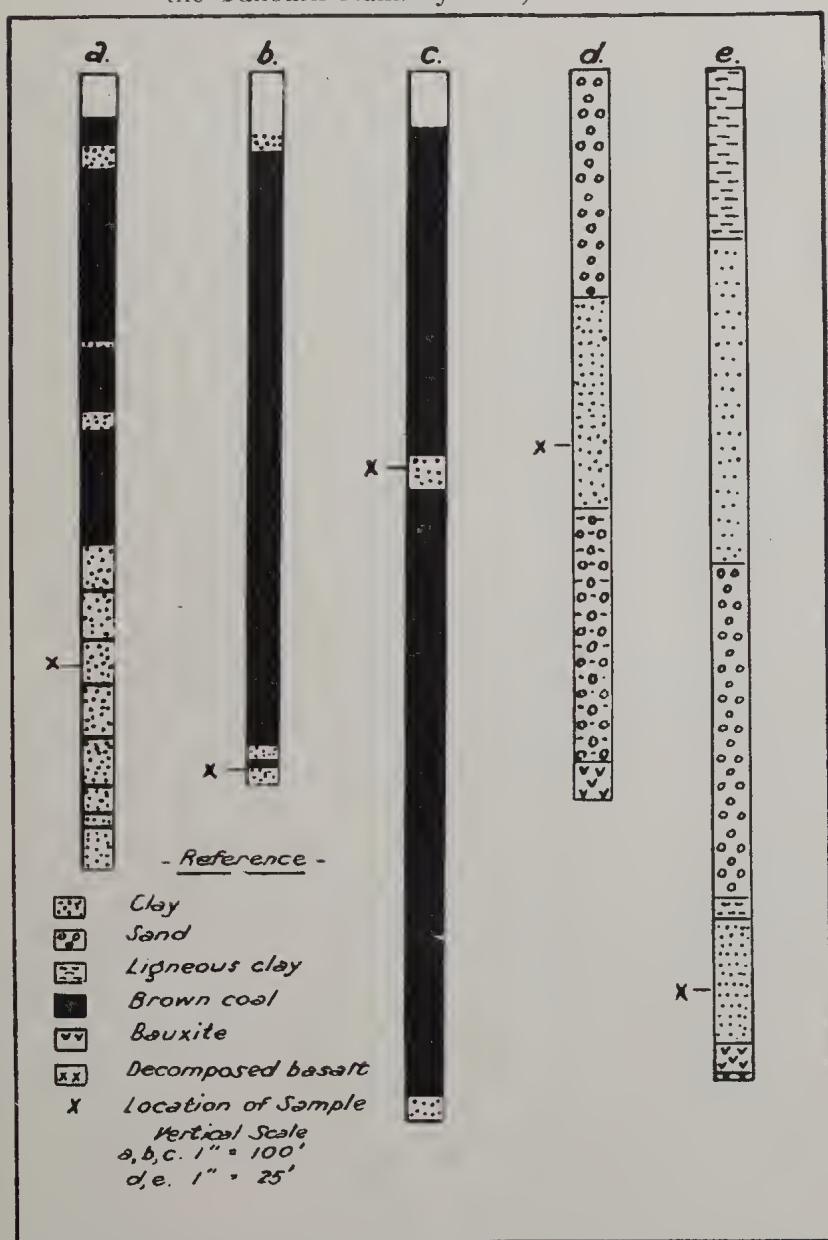
- (e) Bore No. 31 at depth of 335 feet. (Mr. J. M. Bridge of the State Electricity Commission notes that this sample is apparently from below the Morwell No. 1 seam.)

PARISH OF MARYVALE (MORWELL).

- (f) Bore No. 153, from 238 feet to 240 feet below surface. (This sample is 125 feet above the Morwell No. 1 seam and is probably in the Yallourn seam.—J.M.B.).
- (g) Bore No. 155.—First sample at 546 feet below surface. (8 feet below Morwell No. 1 seam, which is 500 feet thick at this locality. Sample was taken between two seams of coal each 3 feet thick.—J.M.B.).
Second sample at depth of 552 feet. (14 feet below Morwell No. 1 seam and 14 feet above No. 2 seam, which is here 189 feet thick.—J.M.B.).
- (h) Bore No. 169, from depth of 312 feet. (86 feet below Yallourn seam and 30 feet above Morwell No. 1.—J.M.B.).
- (i) Bore No. 171.—First sample from 363 feet to 364 feet below surface. (Immediately below Yallourn seam, which is here 301 feet thick.—J.M.B.).
Second sample 558 feet to 560 feet below surface (17-19 feet below Morwell No. 1 seam, which is 78 feet thick at this locality.—J.M.B.).

PARISH OF LOY YANG (TRARALGON).

- (j) Bore No. 84, from 26 feet below surface.
 (k) Bore No. 86, from 597 feet below surface.
 (l) Bore No. 92, from 193 feet below surface.
 (m) Bore No. 96, from 99 feet below surface. (26 feet below a 36-ft. seam, which probably corresponds to the Yallourn seam.—J.M.B.).



TEXT FIG.—Diagrammatic sections of bores. a. No. 109, Ph. Loy Yang, S.L. 240'; b. No. 31, Ph. Hazelwood, S.L. 235'; c. No. 92, Ph. Loy Yang, S.L. 200'; d. No. 27, Ph. Mirboo, S.L. 650'; e. No. 15, Ph. Budgerie, S.L. 1050'.

(n) Bore No. 103 at depth of 300 feet.

(o) Bore No. 109.—First sample from 257 feet; second sample at 295 feet below surface. (65 feet below the last major seam met. It probably corresponds to an horizon immediately below the Morwell No. 2 seam.—J.M.B.).

Distribution of Fossils in the Bores.

The following table lists the fossils noted in the bores detailed above. The letter designations used in the table are the same as those given in the foregoing list:—

Fossils.	Bores.													
	a	b	c	d	e	f	g	h	i	j	k	l	m	n o
FORAMINIFERA—														
Anomalina glabrata Cushman ..	—	—	x	—	—	x	—	—	—	—	—	—	—	—
Anomalina sp. 1 ..	—	—	—	—	x	—	—	—	—	—	—	—	—	—
Astrononion australe Cushman ..	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Cibicides cf. victoriensis Chapman, Parr & Collins ..	—	—	—	—	—	—	—	x	—	—	—	—	—	—
Cyclammina sp. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	x
Eponides sp. ..	x	x	x	x	—	—	x	x	—	x	—	x	—	—
Elphidium crespinae Cush. ..	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Elphidium sp. ..	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Globigerina bulloides d'Orb. ..	—	—	—	x	—	—	x	—	—	—	—	—	—	—
Globigerinoides trilobus (d'Orb.) ..	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Globorotalia cf. canariensis (d'Orb.) ..	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Lagena sulcata (W. & B.) ..	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Marginulina glabra d'Orb. ..	—	—	—	—	—	—	x	—	—	—	—	—	—	—
Planulina wuellerstorfi (Schw.) ..	x	—	—	—	—	—	—	—	—	—	—	—	—	—
ANTHOZOA—														
Mopsea tenuisoni Chapman ..	—	x	x	x	—	—	—	—	—	—	—	—	—	—
BRYOZOA—														
Cellaria sp. ..	—	—	—	—	—	—	—	—	—	—	—	—	—	x
Crateropora patula (Waters) ..	—	—	—	—	—	—	x	—	—	—	—	—	—	—
Filisparsa orakeiensis Stol. ..	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Hornera sp. ..	—	—	x	—	—	—	—	—	x	—	—	—	—	—
Idmonea milneana d'Orb. ..	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Membranipora macrostoma (Reuss) ..	—	—	—	—	x	—	—	—	—	—	—	—	—	—
Retepora rimata Waters ..	—	—	—	x	—	—	—	—	—	—	—	—	—	—
Retepora sp. ..	—	—	—	—	—	—	—	—	—	—	x	—	—	—
Scuticella sp. ..	—	—	x	—	—	—	—	—	—	—	—	—	—	—
Bryozoa indet. ..	—	—	x	x	—	x	x	—	x	—	x	—	—	x
OSTRACODA—														
Aglaia clavata G.S.B. ..	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Alatacythere praeantarticum (Chapman) ..	x	—	—	—	—	—	—	—	—	—	—	—	—	—

Samples from Loy Yang Bores, 96 (m) and 103 (n) contained no fossils.

Notes on the Fossils.

The majority of the fossils listed above are poorly preserved; many of the bryozoa are indeterminate. The fine pores are frequently filled with minute particles of lignitiferous material.

The most important foraminifera of zonal value found in the above bores are *Cyclammina* sp. and *Anomalina* sp. 1, the former being characteristic of the Anglesean Stage (Middle Miocene) and the latter of the Mitchellian Stage (Upper Miocene). (Crespin, 1943.)

Cyclammina is represented by several small, moderately well preserved tests in Loy Yang Bore No. 109 at 295 feet. The Anglesean Stage as represented in bores in East Gippsland, where it underlies rich fossiliferous marls referable to the Janjukian Stage, is not typical of the deposit as found at the type locality at Anglesea in Western Victoria, and it is in consequence of this facies change that the writer (1943) instituted the term "Yallourn formation" for the Gippsland equivalent. She has given the stratigraphic range of *Cyclammina* from the Anglesean Stage up to the Batesford substage of the Balcombian. Except for one record in Sector II. (Providence Ponds), the occurrence of the genus in the Batesford substage is restricted to the deep bores in Sector IV. (Ninety Mile Beach.) In view of this extended stratigraphic range of the genus, it may be unwise to assume that the sample in which *Cyclammina* was found is definitely referable to the Anglesean, but from information available it seems that it came from an horizon low in the Yallourn formation.

The species referred to as *Anomalina* sp. 1 in the Hazelwood Bore No. 31 at 335 feet, has a restricted stratigraphic range. In the Gippsland bores and in the Lakes Entrance Oil Shaft, the species does not occur in a downward direction below the top part of the Middle Miocene, i.e., the Bairnsdale substage of the Balcombian. It is the characteristic species of the Mitchellian Stage (Upper Miocene) and ranges into the basal portion of the Kalimnan Stage (Lower Pliocene).

Cibicides cf. *victoriensis*, *Astronion australe*, and *Elphidium crespinae*, although typical of the Balcombian Stage in Gippsland as well as in other parts of Victoria, have an extended vertical range in Gippsland. *A. australe* is recorded from the Anglesean up to the Kalimnan, where it is fairly common in the basal portion. *C. victoriensis* and *E. crespinae* range from the Anglesean to the Mitchellian, but their characteristic development is in the Balcombian.

Joints of *Mopsea* are common throughout the Balcombian Stage in Gippsland.

All the specimens of bryozoa are poorly preserved. They are all chalky white in appearance and very fragmentary. The assemblage of species is typical of the Middle and Upper Miocene deposits of Gippsland.

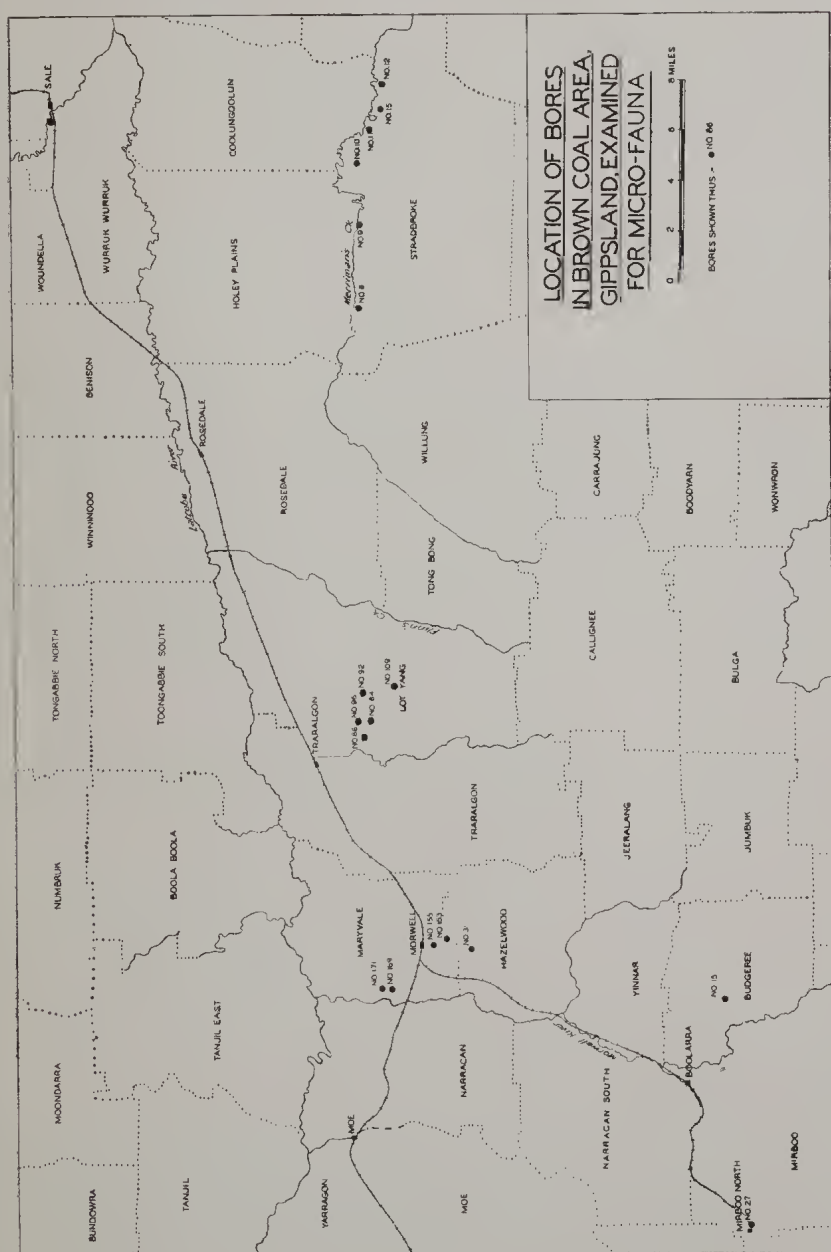
Probable Age of the Brown Coals and the Origin of the Micro-Fauna Contained Therein.

Consideration of the Tertiary stratigraphy, based on the examination of samples from the bores listed above and of numerous sections of deep bores east, south, and south-east of the brown coal deposits, suggests that the brown coals of Gippsland accumulated over a considerable period of time. The basal portion of the Yallourn formation is represented by the Anglesean Stage, which, east of a line running north from the western portion of Ph. Stradbroke through the parishes of Coolungoolun, Wurruk Wurruk, and Bundalagualh to Ph. Stratford, has been proved by boring to underlie the marine fossiliferous beds of the Janjukian Stage. West of that line there was apparently a period of accumulation of material in lakes which lasted from Anglesean times (Middle Miocene) until the close of the Upper Miocene (Mitchellian Stage) or opening of the Lower Pliocene (Kalinman Stage). It is suggested that the brown coals accumulated during this period. During the deposition of the fossiliferous beds to the east, there was some oscillation of the sea-floor bringing about a rise in sea-level. The result was a slight flooding of the lakes to the west by waters containing a few marine forms which were subsequently deposited in the lignitiferous sands.

The above suggestion as to age of the brown coals is substantiated by the presence of the typical Anglesean foraminifer, *Cyclammina*, in the sample from Bore No. 109, Ph. Loy Yang, which is the most easterly bore to be examined and which is situated nearer than the other bores to the main Gippsland Basin described by the writer (1943), and the presence, in Bore No. 31, Ph. Hazelwood, of *Anomalina* sp. 1, which does not appear in the stratigraphic section until the top of the Balcombian stage and which ranges through the Mitchellian to basal Kalinman.

It is estimated that the brown coals are about 1,000 feet thick in the Morwell and Yallourn areas, with the Morwell No. 2 seam representing the lowest horizon. Foraminifera typical of the Anglesean Stage are present (in the Loy Yang Bore No. 109) in the lignitiferous clays which underlie this seam. It is quite probable that certain seams of brown coal in this portion of the area may be correlated with those which occur in many of the deep bores south and east of Sale. In these bores, seams of brown coal were encountered in the Anglesean Stage at considerable depths below the marine fossiliferous beds referable to the Janjukian. A seam 60 feet thick was present in the Sperm Whale Head Bore (Ph. Poole Poole) between the depths of 2,739 and 2,789 feet; 90 feet of brown coal were recorded from the Lake Kakydra Bore (Ph. Nuntin) between 3,041 and 3,131 feet; seams of varying thicknesses occurred in the Holland's Landing Bore (Ph. Bengworden South) and in the Sale Bore (Ph. Wurruk Wurruk). A micro-fauna was found throughout the Anglesean in all these bore sections.

In the lignitiferous clays and sands from bores in the Mirboo and Budgerie areas and in all bores examined in the Morwell and Traralgon areas, except Loy Yang, No. 109, the micro-fauna is typically Balcombian and Mitchellian.



Information derived from the Victorian Boring Records and personal investigation of many bores in the area, indicate that no marine sediments as developed in the Janjukian, Balcombian, and Mitchellian Stages east of a line drawn north from No. 3 Bore, Ph. Darriman through No. 8 Bore, Ph. Stradbroke on Merriman's Creek, along the western boundary of Ph. Coolungoolun to the La Trobe River, thence to the western portion of Ph. Stratford, are known west of that line. A geological section drawn in an east-south-easterly direction from No. 8 Bore, Ph. Stradbroke through other bores along Merriman's Creek to No. 14 Bore, Ph. Giffard, at Seaspray on the Ninety Mile Beach, a distance of about 20 miles, illustrates the gradual thickening, in that direction, of the marine Tertiaries. No. 8 Bore, Ph. Stradbroke, reached the brown coal at 3 feet below the surface, after passing through a few feet of the "Torrent Gravels" of Gippsland. No. 9 Bore, in the same parish and about $1\frac{1}{2}$ miles to the east of No. 8, penetrated the marine fossiliferous beds (probably Janjukian in age) at 32 feet, and struck brown coal at 222 feet. The thickness of the marine beds increases rapidly east of this bore, until in No. 14 Bore, Ph. Giffard, they had not been bottomed at 1,600 feet when drilling ceased, the bore then being in beds referable to the Batesford substage of the Balcombian.

The country north of No. 8 Bore, Ph. Stradbroke to the La Trobe River and west through the parishes of Holey Plains and Rosedale to Moe, has been intensively drilled to prove the extent of the brown coals, but no marine fossiliferous beds have been encountered.

References.

- CHAPMAN, F., 1922.—Notes on the Brown Coal from Morwell, South Gippsland. *Bull. Geol. Surv. Vic.*, 45, pp. 128-130. Reprinted in *Rec. Geol. Surv. Vic.*, 4 (4), 1925, pp. 485-487.
- CRESPIN, I., 1943.—The Stratigraphy of the Tertiary Marine Rocks in Gippsland, Victoria. *Min. Res. Surv. Bull.*, No. 9 (*Pal. Ser.* No. 4).
- HERMAN, H., 1922.—Brown Coals of Victoria. *Bull. Geol. Surv. Vic.*, 45. Mines Department, Victoria, 1938. Records of Boring Operations for years, 1923-1930; 1939. *Idem.* for 1931-1937.
- , 1939.—Annual Report, including Gold and Mineral Statistics, and Boring Records for three years 1938; 1940. *Idem.* for 1939.
- SINGLETON, F. A., 1941.—The Tertiary Geology of Australia. *Proc. Roy. Soc. Vic.*, 53 (1), N.S.

The diagrammatic sections of bores shown in Text-figure 1, have been compiled from bore logs supplied by the Mineral Resources Survey, Canberra and the State Electricity Commission of Victoria.

A map showing various parishes in which the bores examined for micro-fauna are located, is attached. The bore sites in Ph. Stradbroke mentioned in the text, are also included.